ASU Sound & Vibration Lab

معمل الصوتيات والاهتزازات

كلية الهندسة – جامعة عين شمس

Acoustics, 3rd Year Production

2006/2007 – 2nd Semester

Sheet 1: Introduction

1.1 For longitudinal waves in different media the following sound speeds apply:

Air $c \approx 340$ m/s.
Water $c \approx 1500$ m/s.
Steel $c \approx 5000$ m/s.

Determine the wavelength of longitudinal waves in the three media for the frequencies: 100, 1000 and 10000 Hz. Comment. If we want to detect a crack in a steel bar of a thickness of 1um using "sound" waves, what is the magnitude of the frequency that should be used.

1.2 In a factory hall there are N machines, each contributing the sound pressures, $p_1(t)$, $p_2(t)$, ... $p_N(t)$ at a receiver position. It can be assumed that the sound sources are uncorrelated.

a) Derive an expression for the total sound pressure level $L_{p_{tot}}$ at the receiver position as a function of the sound pressure levels L_{pn} of the different machines. It is assumed that all machines run simultaneously.

b) Assuming that the total number of machines is eight and each gives the sound pressure level L_p at the receiver position, what will the total sound pressure level be for the following cases?

(i) Two machines in operation. [Ans: +3 dB]
(ii) Four machines in operation. [Ans: +6 dB]
(iii) Eight machines in operation. [Ans: +9 dB]

1.3 Two machines give the respective sound pressure levels 75 and 73 dB at a receiver point. Determine the total sound pressure level when the machines run simultaneously. [Ans: 77]

1.4 In a factory hall there are $N = 5$ cooling fans, each contributing equally to the noise disturbance in a nearby residential area. The total sound pressure level during the day when all fans are running is $L_{p_{tot}} = 44$ dB. How many fans can be in operation simultaneously during the night if the maximum allowed sound pressure level is $L_{p_{night}} = 40$ dB? [Ans: 2]

1.5 Even in the best of laboratories, there is always a background sound pressure level, L_{Pb}, caused, for instance, by ventilation. This can have an influence on the result when determining the sound pressure level from test objects. If the background level is significant compared to the measured sound pressure level, L_{Ptot}, the results must be corrected to obtain the true sound pressure level of the test object, L_{p_m}.

a) Derive a correction term, $L_{p_{corr}}$, to take account of the background level, L_{p_b}, according to

$L_{p_m} = L_{p_{tot}} + L_{p_{corr}}$ [dB].

b) Determine $L_{p_{corr}}$ if:

(i) $L_{p_{tot}} - L_{p_b} = 3$ dB, [Ans: -3.02]
(ii) $L_{p_{tot}} - L_{p_b} = 4$ dB, [Ans: -2.2]

(*iii*) $L_{p_{tot}} - L_{p_b} = 5$ dB, [Ans: -1.65]

(*iv*) $L_{p_{tot}} - L_{p_b} = 8$ dB, [Ans: -0.75]

(*v*) $L_{p_{tot}} - L_{p_b} = 10$ dB. [Ans: -0.46]

1.6 In an acoustic laboratory used for testing loudspeaker elements, there is a need to measure the sound pressure level down to 35 dB. If the maximum allowed contribution from the background is 0.2 dB, determine the maximum allowed background level. [Ans: 21 dB]

1.7 A man listens to the sound generated by two loudspeakers A & B. The speakers are playing exactly the same harmonic tone "correlated sound sources" with a phase angle ϕ. The pressure signal in Pascal, resulting from the speakers at a certain observer can be put in the form:

$$p_A = 0.1\sin(2000\pi t)$$
$$p_B = 0.1\sin(2000\pi t + \phi)$$

a. Sketch the total pressure signal resulting from both speakers in the following cases:
   i. $\phi = 0^o$.
   ii. $\phi = 90^o$.
   iii. $\phi = 180^o$.
b. What is the sound pressure level due to those speakers in each of the previous cases?